

## REMARKS

Claims 1-14 are pending in the present application. All claims are in condition for allowance for the reasons set forth herein.

### Claim Rejections - 35 USC § 103

Claims 1 and 10-14 are rejected under 35 U.S.C. 103(a), as being unpatentable over Wehrmann et al. in view of Gallagher et al.

According to claim 1 of Wehrmann et al. the electroluminescent element contains at least a hole transport zone and an adjacent hole injection zone. Wehrmann et al. at paragraph [0059] discloses:

"As luminescent material (component C), it is possible to use substances which display photoluminescence, i.e. fluorescent and laser dyes, but also metal complexes and chelates or inorganic nanosize particles"

and at paragraph [0062] Wehrmann et al. discloses:

"Suitable inorganic nanosize particles are, for example, semiconductors such as CdS, CdSe, ZnS or ZnO".

Therefore, Wehrmann et al. only discloses fluorescent ZnS nanosize particles. Wehrmann et al. does not mention doped ZnS, nor do they provide a preparation process for doped ZnS

nanoparticles capable of emitting light under the influence of direct current.

Gallagher et al discloses in claim 1 that:

"A chemically doped precipitated particle of semiconductor material of less than 100Å in diameter encapsulated with a surfactant, the surfactant maintaining a quantum confinement of said particle and further providing a surface passivation of said particle, the dopant concentration of said particle being 0.5-1.0%."

at col. 2, lines 15-19, Gallagher further discloses that:

"Most homogeneous precipitation of nanometer sized undoped particles has used an aqueous salt chemistry (e.g.  $\text{Zn}(\text{ClO}_4)+\text{NaHS}\cdot\text{ZnS}$  in water). The present methodology uses an organometallic chemistry in a hydrocarbon solvent." (emphasis added)

and at col. 2, lines 47-51, Gallagher discloses that:

"The present work utilizes the formation of a metastable intermediate organometallic compound which is compatible with the present ZnS forming reaction to provide the Mn. This is the first known use of a chemical doping process in the precipitation of nanometer sized ZnS particles." (emphasis added)

Therefore the process used by Gallagher for the preparation of nanoparticles of ZnS doped with Mn deviates significantly from that disclosed in present claim 1. This is further shown in the passage from col. 3, line 55, to col. 4, line 40, cited by the Examiner.

With the process disclosed in claim 1 of the present application Mn-doping of ZnS and quantum confinement can be

realized upon precipitation in aqueous media. Gallagher et al. clearly teaches away from the use of aqueous processes to realize quantum-confined nonoparticles of ZnS doped with Mn.

Furthermore, the electroluminescent element, according to combination of the teaching of Wehrmann et al. and the teaching of Gallagher et al. contains at least a hole transport zone and an adjacent hole injection zone, i.e., at least two zones. However, according to claim 1 and the claims dependent thereon and claim 14, the electroluminescent element, as defined in Wehrmann et al., can comprise a single layer containing the doped ZnS (n-type semiconductor) nanoparticles, i.e., an electron transport zone. We therefore contend that claim 1 and the claims dependent thereon and claim 14 cannot be adduced from a combination of Wehrmann et al. and Gallagher et al., which requires the presence of an electroluminescent element with at least a hole transport zone and an adjacent hole injection zone.

We therefore contend that claim 1 and claims 10 to 14 are patentable under 35 USC § 103(a) over Wehrmann in view of Gallagher et al.

Claims 2-9 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Wehrmann et al. and Gallagher et al. as discussed in reference to claim 1 and further in view of Gray.

As stated above, the process used by Gallagher for the preparation of nanoparticles of ZnS doped with Mn deviates significantly from that disclosed in present claim 1. This is further shown in the passage at col. 3, line 55, to col. 4, line 40, in Gallagher, cited by the Examiner.

With the process disclosed in claim 1 of the present application Mn-doping of ZnS and quantum confinement can be realized upon precipitation in aqueous media. Gallagher et al. clearly teaches away from the use of aqueous processes to realize quantum-confined nanoparticles of ZnS doped with Mn.

Gray et al. discloses in claim 1 that:

"Nanocrystalline phosphors comprising a binary II-VI semiconductor host compound doped with Mn; Cu; Ag; Eu; Cu,Cl; Cu,Tb; Tb; Ag,Cl; Cl; Cu,Al; Ce; Er, Er,Cl; or Zn, wherein said doped nanocrystalline phosphor has an average of about one or less dopant ion per nanocrystalline phosphor particle."

at col. 2, lines 26-42, Gray et al. states that:

"The present invention is based upon the availability of stable mesoporous structure provided by Bicontinuous Cubic Phase (BCP) of lipids in the temperature range of 20-100°C. The formation of nanoparticulate materials is achieved by chemical reactions among precursors which are either all or in part embedded within the cubic matrix, or by physical transportation of one or more of the precursors from the outside environment into the mesoporous structure. The

size of the grown crystals is limited by the size of the pores in the matrix and/or by chemical termination achieved by the limited amount precursor(s) available within the matrix. The solubility of surfactant in wide variety of solvents facilitates simple isolation and purification of formed nanoparticles from surfactant and remnant precursor chemicals. The stoichiometric composition of the nanoparticle can be controlled very accurately via the relative concentration of the precursor ions."

As already argued in our response to the first Office Action the preparation of the doped ZnS nanoparticles, according to Gray et al., requires a combination of surfactant and liquid hydrophilic phase at any ratio that produces a bicontinuous cubic phase as described at col. 2, line 62, to col. 3, line 52. In the method for manufacturing doped ZnS, according to the present invention, no surfactant is required. This represents an unexpected simplification of the process according to Gray et al. neither indicated nor hinted at in Gray et al. Therefore, the process for preparing doped ZnS nanoparticles disclosed in present claim 1 differs from, and is inventive over, that disclosed in Gray et al. We also contend that the doped ZnS prepared according to the present invention also differs from that prepared according to Gray et al. Evidence for this contention is provided by particle-size measurements carried out on the doped ZnS nanoparticles prepared according to the present invention, as exemplified at

page 14, line 16, to page 15, line 4, of the present specification.

The present specification further discloses electroluminescence of Cu-doped ZnS, at 490 nm (page 20, line 29), and electroluminescence of Mn-doped ZnS at 590 nm (page 23, lines 5 and 20). Gray et al. discloses Mn-doped ZnS nanoparticles with a photoluminescence emission peak of 590 nm (see figure 2) and copper-doped ZnS with green emission, but provides no evidence of their electroluminescent properties. Gray at col. 7, lines 12-15, merely discloses that:

"Another unique advantage of the nanoparticles according to the present invention is that they are not only photoluminescent but can also be cathodoluminescent and electroluminescent."

This indicates that doped ZnS according to the preparation process disclosed in Gray et al. is not necessarily electroluminescent, whereas doped ZnS prepared according to the process of the present invention exhibits electroluminescent properties.

Furthermore, one skilled in the art would not contemplate combining the non-aqueous preparation technology for quantum-confined manganese-doped zinc sulphide particles disclosed by Gallagher et al., with the aqueous technology preparation technology of Gray et al. Totally different considerations come into play in aqueous media than those in non-aqueous

media and even were one to do so such a combination, in contradiction to the expectations of one in the art, they would not produce the inventions of claims 2 to 9 of the present application.

Finally the Office has alluded to the techniques used for washing and cleaning as being standard techniques. However, it is not the fact that the techniques used are standard techniques which is important, it is the way and combination in which they are used to solve a particular preparation problem that is important, in this case the synthesis of quantum-confined manganese-doped zinc sulfide nanoparticles, which are apparently so difficult to prepare in aqueous media that Gallagher et al. had to resort to unconventional non- aqueous preparation techniques requiring the synthesis and use of more exotic ingredients.

We therefore contend that the inventions of present claims 2 to 9 of the present application cannot be adduced by combining the teachings of Wehrmann et al., Gallagher et al. and Gray et al. and hence that present claims 2 to 9 are patentable under 35 U.S.C. §103(a) over Wehrmann et al. in view of Gallagher et al. and Gray et al.

## CONCLUSIONS

Claims 1-14 are pending in the present application. All claims are in condition for allowance. A notice of allowance for claims 1-14 is respectfully requested.

Respectfully submitted,

  
Joseph T. Guy, Ph.D.

July 11, 2003

Agent for Applicants  
Registration Number 35,172  
NEXSEN PRUET JACOBS & POLLARD, LLC  
P.O. Box 10648  
Greenville, SC 29603  
Telephone: 864-370-2211  
Facsimile: 864-282-1177